14. An image pickup apparatus according to claim 10, wherein an iris is changed at high speed in order to change the exposure amount.

15. An image pickup apparatus according to claim 11, wherein an iris is changed at high speed in order to change the exposure amount.

REMARKS

The claims now pending in the application are Claims 1 to 15, the independent claims being Claims 1 to 3, 10 and 11. Claims 1 to 3, 10 and 11 have been amended.

In the Official Action dated April 24, 2001, the title was objected to on formal grounds. Claims 1, 2, 4, 5, 7, 8, 10, 12 and 14 were rejected under 35 U.S.C. § 103(a), as unpatentable over U.S. Patent No. 5,162,914 (Takahashi), in view of U.S. Patent No. 5,235,427 (Kim), further in view of U.S. Patent No. 5,949,481 (Sekine), and Claims 3, 6, 9, 11, 13 and 15 were rejected under 35 U.S.C. § 103(a), as unpatentable over the Takahashi '914 patent in view of U.S. Patent No. 6,130,709 (Sekine) and the Sekine '481 patent. Reconsideration and withdrawal of the objection and rejections respectfully are requested in view of the above amendments and the following remarks.

Initially, in formal matters, Applicant has proposed a new title which describes more clearly the claimed invention, as requested by the Examiner.

The specification has been amended as to matters of form, including English spelling, grammar, idiom, syntax and the like. No new matter has been added.

By separate paper filed concurrently herewith, Applicant has submitted a Request for Approval to Amend the Drawings. In that Request, Applicant has amended Figs. 12 to improve its form (correspondence). No new matter has been added.

The rejections of the claims over the cited art respectfully are traversed. Nevertheless, without conceding the propriety of the rejections, Claims 1 to 3, 10 and 11 have been amended herein more clearly to recite various novel features of the present invention, with particular attention to the Examiner's comments. Support for the proposed amendments may be found in the original application. No new matter has been added.

The present invention relates to a novel apparatus and method for increasing an apparent dynamic range of a video signal by synthesizing a single image from a plurality of images sequentially picked up at different exposure amounts. In one aspect, as now recited in independent Claim 1, the image pickup method includes detecting a motion vector of a video signal, and if the detection result indicates that the motion vector is larger than a predetermined threshold value, image sensitization is not performed, and a respective single image which is not sensitized is produced.

Independent Claims 2, 3, 10 and 11 recites similar features with respect to an image pickup method or apparatus.

Applicant submits that the prior art fails to anticipate the present invention. Moreover, Applicant submits that there are differences between the subject matter sought to be patented and the prior art, such that the subject matter taken as a whole would not have been obvious at the time the invention was made to one of ordinary skill in the art.

The Takahashi '914 patent relates to an image sensing device with diverse storage fumes used in picture composition, and discloses an image sensing device adapted to compose an appropriate single picture from a plurality of pictures of different exposures obtained from the same subject, wherein the camera operation is controlled using as a reference a single of one the plurality of pictures of different exposures. However, as acknowledged in the Official Action, the Takahashi '914 patent fails to disclose or suggest the feature of detecting a motion vector, and moreover further fails to teach or suggest the feature of controlling image synthesization according to the detected motion vector.

The Kim '427 patent relates to a camcorder and method of controlling recording in accordance with shaking of the camcorder, and discloses a method and apparatus for detecting a shaking condition of a camcorder, and temporarily halting or suspending operation of the camcorder while the camcorder is shaking excessively. However, Applicant submits that the Kim '427 patent fails to disclose or suggest at least the above-described features of the present invention. Rather, Applicant submits that the Kim '427 patent merely teaches a method of stopping operation of the camcorder when vibration thereof, detected by a mercury switch, is larger than a predetermined value. Even if the proposed combination was proper, which Applicant does not concede, Applicant submits the combination of the Kim '427 patent and the Takahashi '914 patent merely would teach inhibiting image synthesization when a motion vector is sufficiently large; nowhere does the Kim '427 patent disclose or suggest the feature of producing a respective single image which is not synthesized, when the motion vector is sufficiently large, as disclosed and claimed in the present application.

The Sekine '481 patent relates to an image sensing and processing device, and was cited merely for its disclosure of the feature of detecting a motion vector. Similarly, the Sekine '709 patent relates to an image processing apparatus for correcting image vibration, and was cited merely for its disclosure of the feature of transforming coordinates of an image in accordance with a motion vector. Applicant submits that neither the Sekine '481 patent nor the Sekine '709 patent discloses or suggests at least the above-described features of the present invention. In particular, neither Sekine reference discloses or suggests the feature of controlling synthesization in accordance with a motion vector in the manner recited in the present claims. Nor are the Sekine references, alone or in any combination with the Kim '427 patent believed to remedy the deficiencies of the Takahashi '914 patent, or otherwise add anything to the Takahashi '914 patent that would make obvious the claimed invention.

For the above reasons, Applicant submits that independent Claims 1 to 3, 10 and 11 are allowable over the cited art.

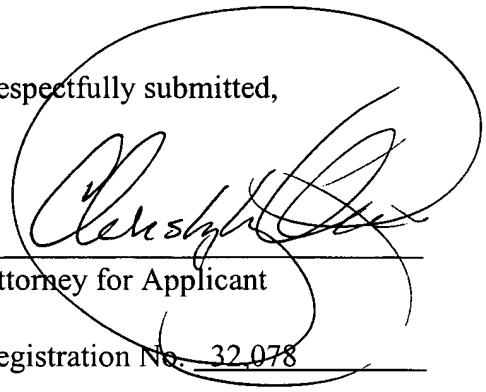
Claims 4 to 9 and 12 to 15 depend from Claims 1, 2, 3, 10 and 11, respectively, and are believed allowable for the same reasons. Moreover, each of these dependent claims recites additional features in combination with the features of its respective base claim, and is believed allowable in its own right. Individual consideration of the dependent claims respectfully is requested.

Applicant believes that the present Amendment is responsive to each of the points raised by the Examiner in the Official Action, and submits that the application is in

allowable form. Favorable consideration of the claims and passage to issue of the present application at the Examiner's earliest convenience earnestly are solicited.

Applicant's undersigned attorney may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should continue to be directed to our below listed address.

Respectfully submitted,



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VERSION WITH MARKS TO SHOW CHANGES MADE TO SPECIFICATION

Please substitute the paragraph starting at page 3, line 6 and ending at line 12, with the following replacement paragraph.

--In consideration of the above-described problems, an object of the present invention is to provide an image pickup method and an image pickup apparatus capable of picking up an image with a broad substantial dynamic range without [the] image shift, even with video cameras or still video cameras which are likely to be subject to image shifts.--

Please substitute the paragraph starting at page 8, line 10 and ending at line 11, with the following replacement paragraph.

--Fig. 12 is a block diagram showing the specific structure of the VTR of the embodiment of Figs. 11A to 11C.--

Please substitute the paragraph starting at page 8, line 12 and ending at line 13 with the following replacement paragraph.

--Fig. 13 is a timing chart illustrating the operation of the VTR of the embodiment of Figs. 11A to 11C.--

Please substitute the paragraph starting at page 9, line 17, and ending at line 25 with the following replacement paragraph.

--The video signal output from the camera unit 100 is an analog signal which is supplied to the processing unit 200 [100] and converted into a digital signal by an A/D converter 201. Pixel data of the converted digital signal is then converted by an operation (computing) circuit 202 in a manner to be described later. Thereafter, the converted pixel data is converted back into an analog signal by a D/A converter 203 and supplied to the recording unit 300.--

Please substitute the paragraph starting at page 11, line 8, and ending at line 13, with the following replacement paragraph.

--Next, the details of the operation of the image pickup element 103 will be described. Fig. 2 is a block diagram showing a [the] more detailed structure of the camera unit 100, and Fig. 3 is a timing chart illustrating [the] operation of the camera unit 100 assuming that NTSC signals are used.--

Please substitute the paragraph starting at page 12, line 3 and ending at line 12, with the following replacement paragraph.

--In the example shown in Fig. 3, during the first blanking period, and during the next effective period, the 1/1000 sec. accumulation signal is output. Immediately after the 1/1000 sec. accumulation period, the substantial [60] 1/60 sec. charge accumulation is performed, and during the next field effective period, the 1/60 sec. accumulation signal is output. In this manner, signals of different [difference] light amounts (1/1000 sec. and 1/60 sec.) are alternatively output for each field.--

Please substitute the paragraph starting at page 13, line 23, and ending at page 14, line 5, with the following replacement paragraph.

--As opposed to [different from] the above embodiment CCD, a CCD having a high speed shutter function of a VOD type has been recently used. This type drains unnecessary charges in the vertical direction of a CCD substrate, and can set the shutter speed very finely. If this CCD is used, the camera drive circuit 105 can set an optimum shutter speed which is judged by the AE control circuit 20 of the control circuit 108 in accordance with a brightness difference between a main object and a background object.--

Please substitute the paragraph starting at page 15, line 1 and ending at line 12, with the following replacement paragraph.

--Since the memory image is formed by a signal delayed by one field, the "crushed white" and "crushed black" are formed in [the] fields different from those of the through images. Therefore, if the through and memory images are properly combined, an image of [a] good quality without the "crushed white" and "crushed black" can be obtained. Namely, signals of the through and memory images are compared with predetermined threshold values at each field to discriminate between the "crushed white" and "crushed black" of each pixel, by setting "1" if the signal of each pixel is larger than the threshold value, and "0" if smaller.--

Please substitute the paragraph starting at page 15, line 13 and ending at line 25, with the following replacement paragraph.

--Figs. 6A and 6B show the relation between threshold values, pixel brightness levels, and fields. The abscissa of Fig. 6A indicates the brightness level, and the ordinate indicates an occurrence frequency of each brightness level in one frame. As shown in Fig. 6A, a first threshold value Th1 is set so that the "crushed black" can be discriminated, whereas a second threshold value Th2 is set so that the "crushed white" can be discriminated. That is, a brightness level equal to or <u>lower</u> [higher] than the first threshold value Th1 is judged as the

"crushed black", whereas a brightness level equal to or higher than the second threshold value Th2 is judged as the as "crushed white".--

Please substitute the paragraph starting at page 19, line 12 and ending at line 16, with the following replacement paragraph.

--Arrows [Rows] (a) to (d) shown in Fig. 9 correspond to signals (a) to (d) shown in Fig. 8. The image pickup device 103 capable of performing the above operation may be a MOS solid image pickup device of an XY addressing type.--

Please substitute the paragraph starting at page 20, line 10 and ending at line 16, with the following replacement paragraph.

--A switch 46 changes its contact point alternately at each field to alternately apply the AE control signal of the AE control signal generator 43 and the AE control signal held by the control signal holding circuit, to the iris drive [control] circuit 106. A switch signal generator 47 controls the switching of the switches 45 and 46 which are synchronously switched.--

Please substitute the paragraph starting at page 20, line 17 and ending at line 23, with the following replacement paragraph.

--In the above example, [the] clock generators for generating high and low speed clock pulses [clocks] are provided, and the high and low speed clock pulses [clocks] are switched in response to a signal of the switch signal generator output at each field. Accordingly, the circuit structure and operation can be simplified, which is [are] particularly suitable for moving images.--

Please substitute the paragraph starting at page 23, line 15 and ending at line 18, with the following replacement paragraph.

--The video signal of the common area shown in Fig. 11A is output from the first field memory 204a and converted into a signal of the original type (e.g., NTSC signal), same as the input signal.--

Please substitute the paragraph starting at page 24, line 3 and ending at line 12, with the following replacement paragraph.

--The addition signal is supplied via the terminal A of the selector 202c and via the EVEN terminal of another selector 209 [207] to the D/A converter 203. The addition signal is also supplied via the terminal A of the selector 202c to the second field memory 204b. During the next odd field, new odd field information is stored in the second field memory 204b while the same video signal is supplied to the D/A converter 203 via the ODD terminal of the selector 209 [207] through a read-modify-write operation.--

Please substitute the paragraph starting at page 24, line 13 and ending at line 17 with the following replacement paragraph.

--A switch 208 is open for the odd field and closed [close] for the even field. While the new odd field information is written in the second field memory, the adder 202b is made through by connecting to the terminal E.--

Please substitute the paragraph starting at page 24, line 18 and ending at page 25, line 6, with the following replacement paragraph.

--The terminal A of the selector 202c is supplied with the addition signal, the terminal O is supplied with the odd field information output from the second field memory 204b, and the terminal E is supplied with the even field information. If the selection signal from the

motion vector comparison circuit 207 indicates that a pixel has a motion caused by hand vibration, the addition signal is selected, whereas if the selection signal indicates that a pixel has a motion other than by hand vibration, a video signal of either the even or odd field having a proper exposure is selected. The selected signal is supplied to the next stage selector 209 [207] and second field memory 204b. A video signal generated in the above manner is output from the D/A converter 203 in the form of an analog signal, same as the original input signal.--

Please substitute the paragraph starting at page 26, line 1 and ending at line 7, with the following replacement paragraph.

--A signal indicated at D shows a switching timing of the selector 209 [207]. Image information synthesized from the odd field image information during a period t1 and the even field image information during a period t2 is output during a period t2, and the same synthesized image information is again read and output during a period t3.--

Please substitute the paragraph starting at page 26, line 8 and ending at line 15, with the following replacement paragraph.

--In synthesizing an image, if it is judged that a pixel has a motion other than by hand vibration, a video signal of either the even or odd field having a proper exposure is selected, as [so that] a time axis shift of the image may be feared. However, this does not pose any practical problem, as described with an example of a calculation process for a synthesized image shown in Fig. 4.--

Please substitute the paragraph starting at page 26, line 16 and ending at line 23, with the following replacement paragraph.

--As described previously, in this embodiment, each process is performed in the unit of two fields. A line interpolation process may be interchanged between the odd and even fields to make it compatible with interlacing and reduce so-called field interference. In order to reduce this field interference, a line interpolation circuit is inserted at a point Q between the second field memory204b and selector 209 [207].--

Please substitute the paragraph starting at page 27, line 11 and ending at line 16, with the following replacement paragraph.

--In this case, the software program codes themselves realize the embodiment functions. Therefore, the program codes [code] themselves and means for supplying such

program codes to a computer, e.g., a storage medium storage such program codes, also constitute the present invention.--

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VERSION WITH MARKS TO SHOW CHANGES MADE TO CLAIMS

1. (Amended) An image pickup method for [of] increasing an apparent dynamic range of a video signal by synthesizing a single image from a plurality of images sequentially picked up at different exposure amounts, wherein a motion vector of a video signal is detected, and if the detection result indicates that the motion vector is larger than a predetermined threshold value, image synthesization is not performed, and a respective single image which is not synthesized is produced.

2. (Amended) An image pickup method for [of] increasing an apparent dynamic range of a video signal by synthesizing a single image from a plurality of images sequentially picked up at different exposure amounts, comprising:

a motion vector detecting step of detecting a motion vector between corresponding pixels in the plurality of images;

a vector difference detecting step of detecting a difference between a motion vector detected in [at] said motion vector detecting step and a motion vector between the plurality of images;

a comparison step of comparing the detection result of said vector difference detecting step with a predetermined threshold value; and

a synthesization inhibiting step of inhibiting [the] image synthesization if the comparison result in [at] said motion vector comparison step is larger than the

predetermined threshold value, wherein a respective single image which is not synthesized is produced.

3. (Amended) An image pickup method for [of] increasing an apparent dynamic range of a video signal by synthesizing a single image from a plurality of images sequentially picked up at different exposure amounts, comprising:

a motion vector detecting step of detecting a motion vector between corresponding pixels in the plurality of images;

a vector difference detecting step of detecting a difference between a motion vector detected in [at] said motion vector detecting step and a motion vector between the plurality of images;

a comparison step of comparing the detection result of said vector difference detecting step with a predetermined threshold value;

a coordinate converting step of performing a coordinate conversion of the plurality of images in correspondence with an image shift caused by a time difference when the plurality of images are picked up, if the comparison result at said motion vector comparison step is smaller than the predetermined threshold value: and

an image synthesizing step of synthesizing the plurality of images with the image shift corrected at said coordinate converting step, into a single image, if the comparison result at said motion vector comparison is larger than the predetermined

threshold, wherein said image synthesizing step is inhibited and a respective single image which is not synthesized is produced if the comparison result at said motion vector comparison is smaller than the predetermined threshold.

10. (Amended) An image pickup apparatus in which an apparent dynamic range of a video signal is increased by synthesizing a single image from a plurality of images sequentially picked up at different exposure amounts, comprising:

motion vector detecting means for detecting a motion vector of the video signal;

comparison means for comparing a [the] detection result by said motion vector [difference] detecting means with a predetermined threshold value; and

synthesization inhibiting means for inhibiting [the] image synthesization if the comparison result by said comparison means is larger than the predetermined threshold value, while a respective single image which is not synthesized is produced.

11. (Amended) An image pickup apparatus in which an apparent dynamic range of a video signal is increased by synthesizing a single image from a plurality of images sequentially picked up at different exposure amounts, comprising:

motion vector detecting means for detecting a motion vector between corresponding pixels in the plurality of images;

vector difference detecting means for detecting a difference between a motion vector detected by said motion vector detecting means and a motion vector between the plurality of images;

comparison means for comparing the detection result by said vector difference detecting means with a predetermined threshold value;

coordinate converting means for performing a coordinate conversion of the plurality of images in correspondence with an image shift caused by a time difference when the plurality of images are picked up, if the comparison result by said motion vector comparison means is smaller than the predetermined threshold value; and

image synthesizing means for synthesizing the plurality of images with the image shift corrected by said coordinate converting means, into a single image, if the comparison result at said motion vector comparison is larger than the predetermined threshold, wherein image synthesization by said image synthesizing means is inhibited while a respective single image which is not synthesized is produced if the comparison result at said motion vector comparison is smaller than the predetermined threshold.

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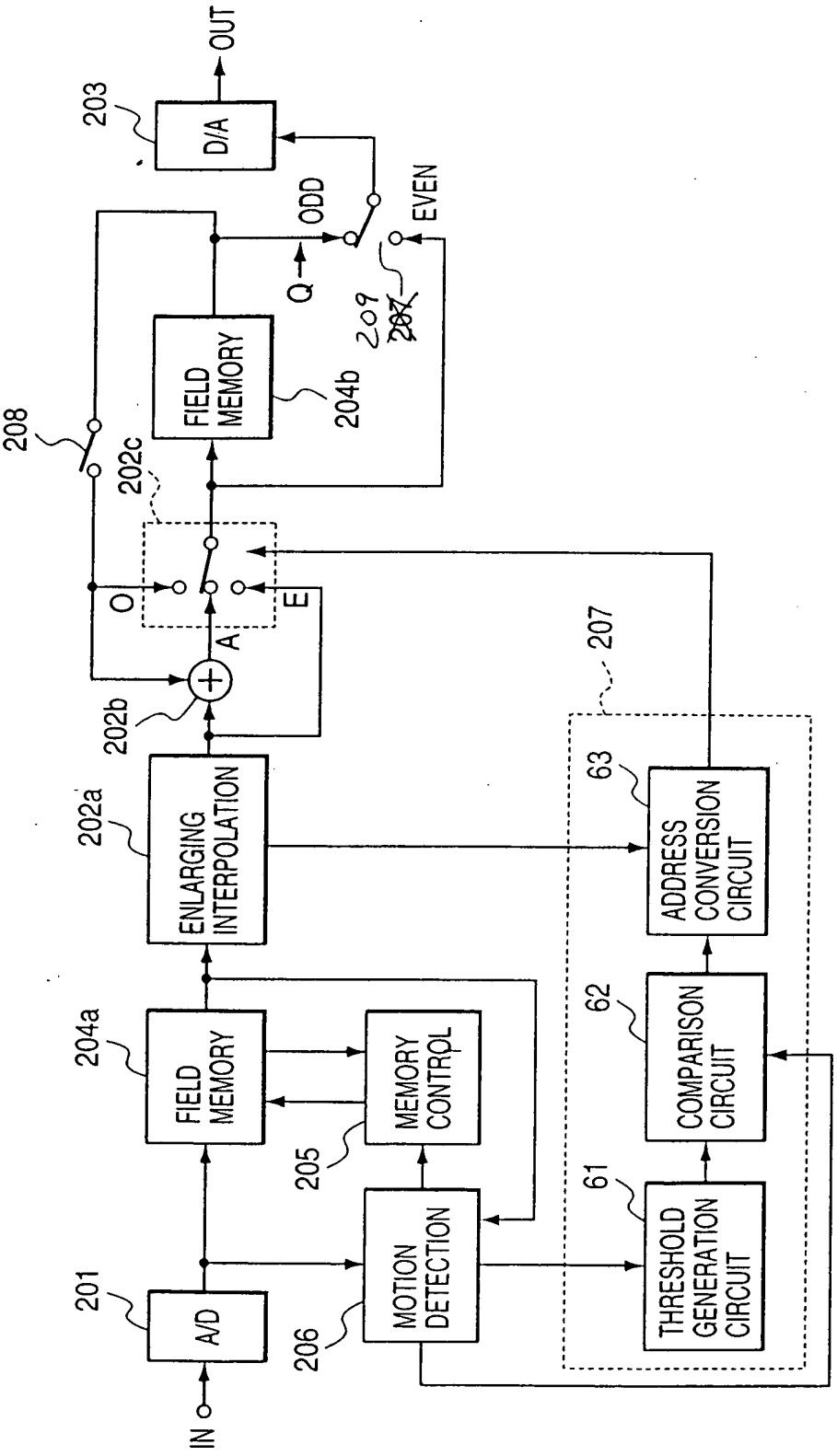
FIG. 12


IN
A/D
201
FIELD MEMORY
204a
ENLARGING INTERPOLATION
202a
202b
O
A
E
202c
208
FIELD MEMORY
204b
Q
ODD
EVEN
209
D/A
203
OUT
MEMORY CONTROL
205
MOTION DETECTION
206
207
ADDRESS CONVERSION CIRCUIT
63
COMPARISON CIRCUIT
62
THRESHOLD GENERATION CIRCUIT
61